HIGH RESOLUTION CHRONOLOGY OF LATE CRETACEOUS - EARLY TERTIARY EVENTS DETERMINED FROM 21,000 YR ORBITAL-CLIMATIC CYCLES IN MARINE SEDIMENTS; Timothy D. Herbert and Steven D'Hondt, Department of Geological and Geophysical Sciences, Princeton University.

A number of South Atlantic sites cored by the Deep Sea Drilling Project recovered late Cretaceous and early Tertiary sediments with alternating light-dark, high-low carbonate content. The sedimentary oscillations were turned into time series by digitizing color photographs of core segments at a resolution of about 5 points/cm. Spectral analysis of these records indicates prominent periodicity at 25-35 cm in the Cretaceous intervals, and about 15 cm in the early Tertiary sediments. The absolute period of the cycles that is determined from paleomagnetic calibration at two sites (516F and 528) is 20,000- 25,000 yr, and almost certainly corresponds to the period of the earth's precessional cycle. These sequences therefore contain an internal chronometer to measure events across the K/T extinction boundary at this scale of resolution. We use the orbital metronome to address several related questions: the position of the K/T boundary within magnetic chron 29R, the fluxes of biogenic and detrital material to the deep sea immediately before and after the K/T event, the duration of the Sr anomaly, and the level of "background" climtic variability in the latest Cretaceous time.

The carbonate/color cycles that we analyze contain primary records of ocean carbonate productivity and chemistry, as evidenced by bioturbational mixing of adjacent beds and the weak lithification (hence minimal diagenetic alteration) of the rhythmic sequences. Site 516F provides a record of approximately 13 Myr of climatic variability prior to the K/T event. Periods of sedimentary cycles are consistent over a number of chrons, indicating both the truly periodic nature of the rhythms, and the nearly continuous deposition at the site. Deposition at site 528 was interrupted by turbidites in portions, but is pelagic during chron 29R. Sedimentation rates in site 516F prior to the K/T event range from 10 m/Myr to 1.6 m/Myr, but with very gradual changes in accumulation as shown by smooth spatial frequency shifts of the orbitally-driven sedimentary cycles.

Counting the 21,000 yr (21 kyr) cycle units between the base of chron 29R and the K/T boundary, one obtains approximately 400 kyr at sites 516F and 528. Because there is no change in the spacing of the sedimentary cycles before the boundary, there is no evidence for changes in climatic variance or biogenic productivityf prior to the event. Given the total duration of chron 29R of 570 kyr (1), geochemical data, and the bulk density of the sediments, one can estimate the changes in accumulation rate of sedimentary components across the boundary at a number of deep sea sites. Carbonate accumulation decreases by factors of 1.4 to 3.25 from the latest Cretaceous to the earliest Tertiary in the paleomagnetically calibrated DSDP sites 516F, 528, and 577, and in the Italian Gubbio and Moria sections, with a mean decrease of a factor of 2.25 times. The abrupt drop in carbonate accumulation resembles a step function, and persists at the sites for a least another 500 kyr after the end of chron 29R. The decline in carbonate accumulation confirms that reduced surface to deep $\delta^{13}C$ gradients indicate drastically reduced oceanic fertility following the K/T event. In addition, most sites show a drop in the accumulation rate of detrital material in the earliest Paleocene.

We conclude that sedimentary sequences that contain orbital cyclicity are capable of providing resolution of dramatic events in earth history with much greater precision than obtainable through radiometric methods. Our data show no evidence for a gradual climatic deterioration prior to the K/T extinction event, and argue for a geologically rapid (1 yr- 20 kyr) revolution at this horizon. As core coverage increases, a reliable chronology of latest Cretaceous and early Tertiary geochemical, physical oceanographic, and evolutionary changes should emerge.

References: (1) Berggren, W.A., Kent, D.V., Flynn, J.J., and Van Couvering, J.A., 1985. Geol. Soc. Amer. Bull. 96: 1407-1418.